Chinook Salmon Spawning Study
Russian River
Fall 2002-2003

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INTRODUCTION

Chinook salmon native to the Russian River basin were considered nearly extinct in the 1980's but in recent years have been found in increasing numbers. The Sonoma County Water Agency (Agency) began conducting Chinook salmon spawning surveys during fall 2002 over concerns that reduced water releases from Lake Mendocino may impact migrating and spawning Chinook salmon (Cook 2003). Releases were curtailed from the lake during fall 2002 due to below normal rainfall and historically low levels in the lake. Water releases from Lake Mendocino provide most of the flows in the upper Russian River during the fall season when adult Chinook salmon migrate upstream to spawn.

In 2003 water releases from Lake Mendocino were normal and were not expected to effect spawning salmon. We continued our spawning surveys in fall 2003 to determine the distribution and abundance of Chinook salmon spawning sites for comparison with the previous year's results. Background information on the natural history of Chinook salmon presented in Cook (2003) has been incorporated in this report.

Life History

Russian River Chinook salmon follow the life history pattern of fall-run Chinook salmon, which is an adaptation to avoid summer high water temperatures. Fall-run adult salmon migrate from the ocean to spawn in rivers and large tributaries in late summer and fall. Spawning occurs within a few days or weeks of arriving at a spawning ground. Adults create a nest, called a redd, by digging a shallow depression in the streambed with their caudal (tail) fin. Females deposit between 2,000 and 17,000 eggs in a redd that settle into the rocky substrate. Redds are usually located at the head of riffles with large gravel to cobble substrate to ensure oxygenated water flows to the eggs. Adults die soon after spawning. Eggs hatch within 4 to 6 weeks and young salmon emerge from the substrate in spring and move downstream within a few months. Young Chinook salmon may rear for a short time in the mainstem of rivers or estuaries during spring before water temperatures increase in the summer. Young salmon are called smolts while they are acclimating to salinity. Once accustomed to saltwater, smolts head out to sea where they spend between 1 to 5 years maturing before returning to their natal stream to spawn and complete their lifecycle.

Historic Runs

The historic occurrence of Chinook salmon in the Russian River is debated; however, the scant available historic sources suggest that Chinook salmon were rare in the river. Rigorous field studies of Russian River Chinook salmon did not begin until the late 1990s (Chase et al. 2000). Steiner (1996) compiled several sources from the late-1800s and early-1900s that suggested there were few Chinook salmon in the Russian River. Moyle (2002) indicated that Chinook

salmon "disappeared with the advent of agriculture and water projects in the basin." Stocking attempts began as early as 1881 with 15,000 Chinook salmon planted in the mainstem without success (USACOE 1982; Steiner 1996). Heavy planting in Dry Creek, starting in the 1980s, did not establish a viable run (Steiner 1996). Hatchery fish were primarily from Sacramento River and Klamath River stocks (Myers et al. 1998, cited in Moyle 2002). The first attempt at a population estimate was in the early 1960s at 500 spawning adults and an additional 2,000 "salmon" taken by fishermen; however, this estimate "involved no field work" and "were made by men who are familiar with the [river]" (CDFG 1965). The reference to "salmon" presumably includes both Chinook salmon and coho salmon. By 1982 Chinook salmon were considered "not currently established in the Russian River" except for occasional observations "possibly a vestige of prior attempts at establishing a viable population" (USACOE 1982). Also, by the 1990s Steiner (1996) concluded that there were currently few hatchery or wild Chinook salmon in the Russian River basin. However, recent observations indicate that Chinook salmon numbers are higher than historic accounts (Chase et al. 2000, 2001, 2003, and 2004). Recent genetic studies indicate that Chinook salmon in the Russian River are a unique wild run and not hatchery stock from outside the basin (Hedgecock et al. 2002).

METHODS

This study consisted of redd surveys in the upper Russian River basin and video monitoring of migrating adult Chinook salmon conducted as part of the Agency's Mirabel Inflatable Dam/Wohler Pool Fish Sampling Program. The study area in 2002 and 2003 included approximately 113 km of the upper Russian River from the East and West Forks of the Russian River near Ukiah to Riverfront Park south of Healdsburg. In 2003, we added 22 km of Dry Creek from Warm Springs Dam to the confluence with the Russian River. Dry Creek is the second largest tributary of the Russian River and drains 217 square miles.

Inflatable dam (left) and fish ladder (right)

Underwater Video Monitoring

Underwater video cameras were used to document the number of Chinook salmon in the Russian River during the fall migration (see Chase et al. 2003 and Chase et al. 2004 for detailed descriptions of methods). Cameras were installed at 2 fish ladders located at the Agency's inflatable dam near Wohler Road Bridge, 12 km downstream of the Dry Creek confluence with the Russian River. Time-lapse cameras recorded the upstream migration of adult Chinook salmon. Video monitoring was conducted continuously, 24 hours a day, from August 12 through December 11, 2002 and September 4 through December 2, 2003. The video monitoring ended when heavy rainfall required the deflation of the dam. It is likely that Chinook salmon migration continued after the cameras were removed and would not have been documented. In addition,

Underwater video camera

adults migrating to spawning habitat in tributaries below the video monitoring station would not have been documented by our monitoring. For example, Chinook salmon are known to spawn in Austin Creek, located near the Russian River Estuary and below our monitoring station (David Hines, NOAA Fisheries, unpubl. data)

Redd Surveys

The Russian River was sampled during fall 2002 and 2003, and Dry Creek was sampled in fall 2003. The upstream migration of Chinook salmon recorded by video monitoring was used to coordinate the timing of redd surveys. The Russian River and Dry Creek study area was sectioned into 6 reaches based on gradient and surrounding topography, including:

- Ukiah reach (east and west fork confluence to Highway 101 bridge near Hopland),
- Canyon reach (Highway 101 bridge near Hopland to Big Sulphur Creek confluence),
- Alexander Valley reach (Big Sulphur Creek confluence to Alexander Valley Road bridge),
- Upper Healdsburg reach (Alexander Valley Road bridge to Dry Creek confluence),
- Lower Healdsburg reach (Dry Creek confluence to Riverfront Park), and
- Dry Creek reach (Warm Spring Dam to Russian River confluence).

Surveys were conducted to determine the distribution and abundance of Chinook salmon redds and spawning habitat utilized. Surveys were initiated after video monitoring indicted a peak in adult Chinook salmon migration. The study area was surveyed once between November 4 and November 26 during 2002 and 2003 survey seasons. A crew of 3 biologists would survey a reach by kayak and visually search for redds along the streambed. Coordinates of observed redds were recorded using a global positioning system (GPS). Habitat characteristics of spawning sites (i.e., substrate size, water depth and velocity, etc) were qualitatively described.

The number of redds counted during surveys likely underestimated the true number of redds deposited during the annual spawning period. This underestimate is likely due to the single-pass survey method and difficulty in occasionally distinguishing individual redds. As mentioned above, redd surveys were conducted after video monitoring indicated a peak in migration activity; however, additional redds could have been deposited after our single-pass survey of the study area. Identification of individual redds was difficult at high density spawning grounds because some redds were covered or obscured by overlapping redds. In the Ukiah reach during 2002 the number of redds was visually estimated at several densely clustered sites. Also, Chinook salmon likely spawned in large tributaries outside of the study area.

RESULTS

Video Monitoring

A total of 5,365 adult Chinook salmon were observed at the video monitoring station during fall 2002 and 6,081 during fall 2003 (Figure 1, Chase et al. 2003 and 2004). A few Chinook salmon began migrating in late summer, but large numbers were not observed until mid- to late fall. During 2002, the first observation of Chinook salmon occurred on August 20. During 2003, Chinook salmon were documented on the first day of monitoring on September 4. Migration continued through the end of monitoring in early December of each year. During both monitoring years peak Chinook salmon migrations occurred during October through early

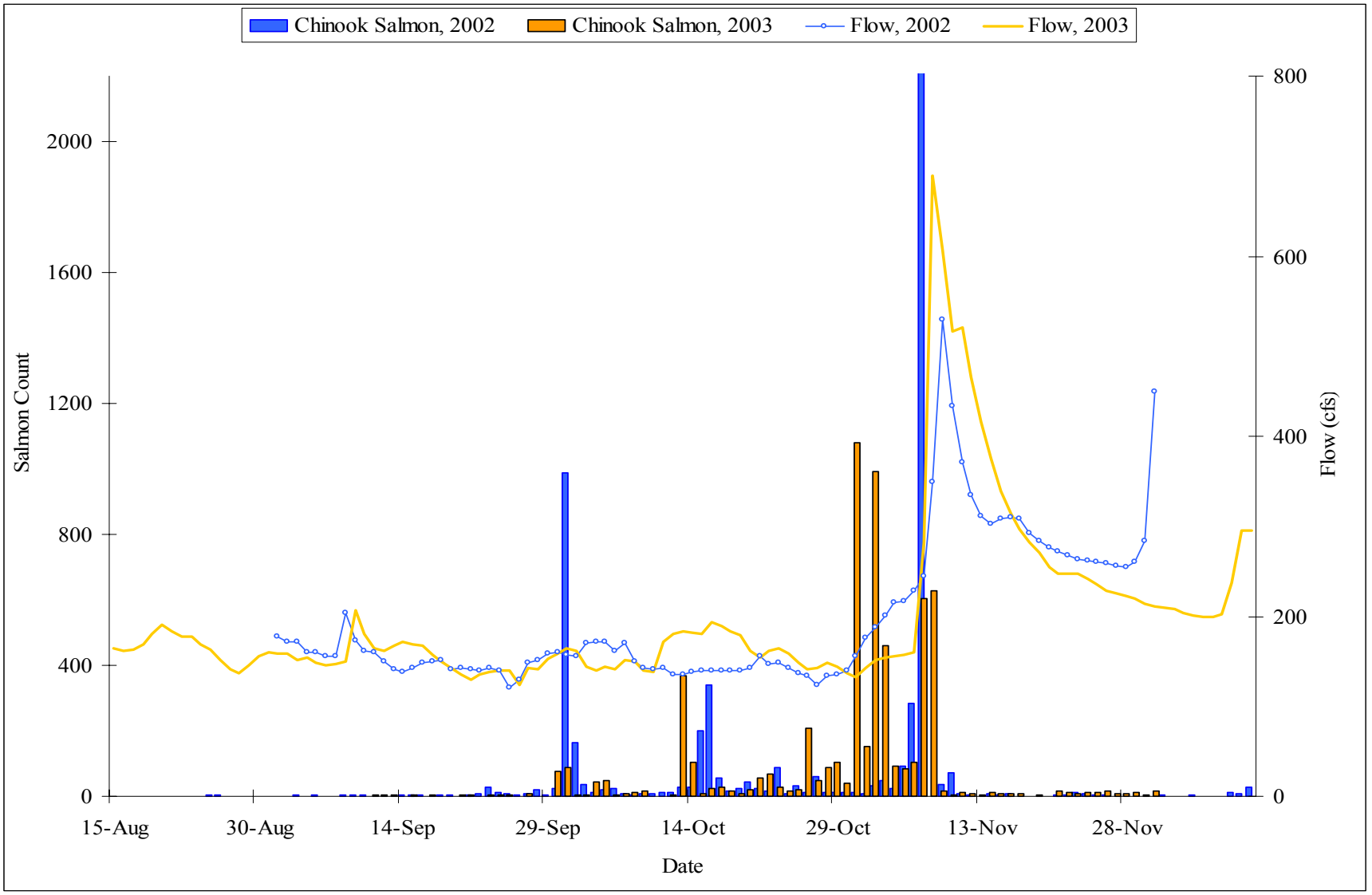


Figure 1: Chinook salmon observations and instream flow at the Sonoma County Water Agency's inflatable dam fish ladder, fall 2002 and 2003.

November. Several peak migrations corresponded with increased flows from rainfall and the removal of summer dams. The first relatively small pulse of migrating Chinook salmon during both study years occurred on October 1 and 2. No significant rain event occurred at this time; however, migration of fish corresponded with the removal of a summer dam, located in the Guerneville area and downstream of Agency's video monitoring station. During the 2002 monitoring period there were 3 major peaks in Chinook salmon migration activity. The largest 1-day peak observation was 2,213 Chinook salmon, or 41% of the observed fish. This peak appeared to be initiated by the first large rain event of the season and a substantial increase of river flows. During 2003 there were several days with high counts of migrating salmon between October 13 and November 8, which corresponded with rainfall and increased flows in the river. The largest one-day count of migrating Chinook salmon during 2003 was on October 31 with 1,079 fish observed.

Redd Abundance

A total of 1,038 Chinook salmon redds during fall 2002 and 907 during fall 2003 were observed in the upper Russian River. During fall 2003, 256 redds were observed in the Dry Creek reach (Figure 2). In the Russian River, there was a similar trend in redd frequencies during both study years. The occurrence of redds increased upstream from Lower Healdsburg reach to Ukiah reach. Lower Healdsburg reach had the lowest frequency of redds at 0.7 redd/km in 2002 and none in 2003. Upper Healdsburg reach had relatively low frequencies at 3.7 redds/km in 2002 and 1.56 redds/km in 2003. The frequency of redds in the Alexander Valley reach during 2002 was half that observed in the Canyon reach (6.4 redds/km and 13.3 redds/km, respectively), but had similar values in 2003 (9.3 redds/km and 8.0 redds/km, respectively). Ukiah reach had the highest frequency of redds of any reach during both study years at 15.1 redds/km in 2002 and

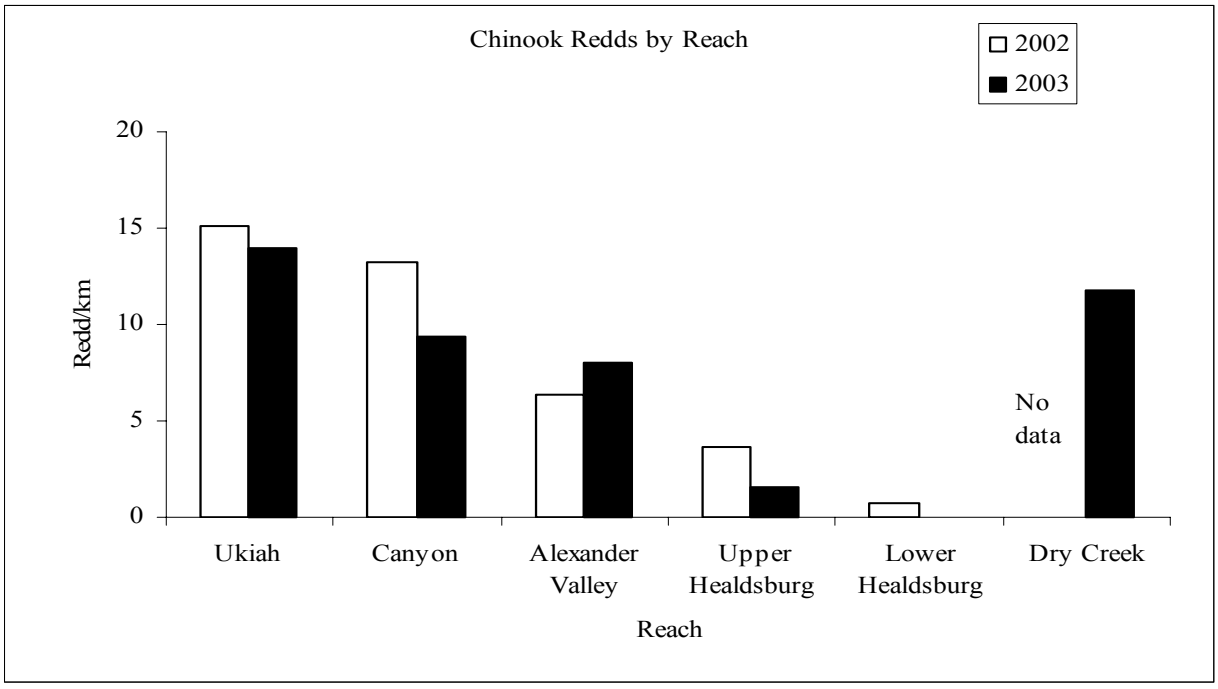


Figure 2: Chinook salmon redd frequences along reaches of the upper Russian River.

14.0 in 2003. During 2003, Dry Creek reach had a redd frequency of 11.8 redds/km, which is similar to the Ukiah and Canyon reaches.

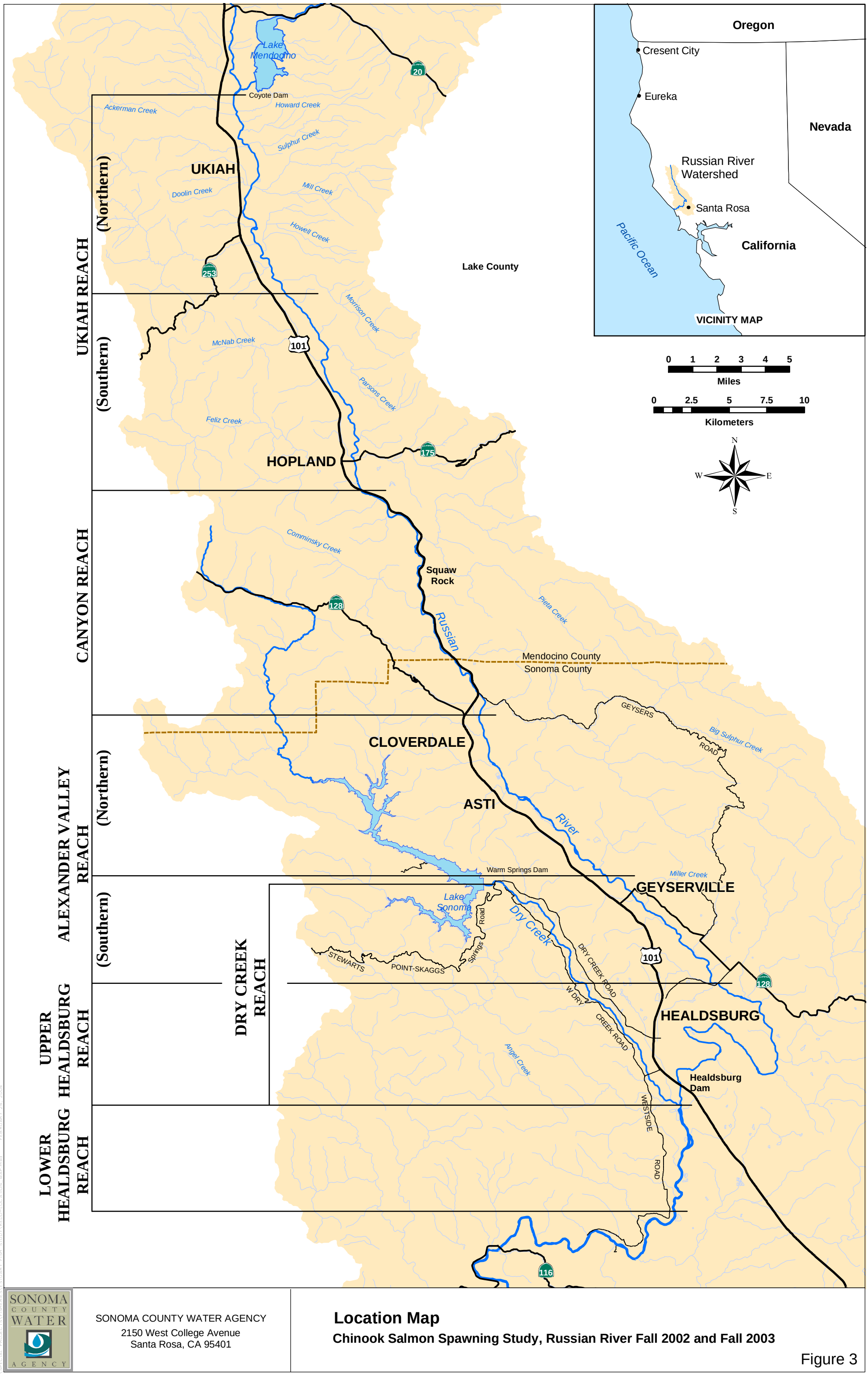
Flows in Dry Creek are maintained by releases at Warm Springs Dam and are substantially higher than natural flows during the fall migration period. As the name of this creek suggests, historically, Dry Creek was usually "dry" during the late summer and early fall prior to the rainy season. During the 2003 peak migration period for Chinook salmon (October 13 through November 8) flows in the Russian River at Healdsburg, located upstream of Dry Creek, averaged 179.2 cubic-feet/second (cfs), while Dry Creek flows averaged 100.6 cfs. Dry Creek contributed 36% of the flow to the Russian River downstream of the confluence during the peak migration period for Chinook salmon.

Redd Distribution and Habitat

The distribution of Chinook salmon redds in the Russian River was similar to the distribution of redds observed in 2002 (Figures 3 through 8). The relatively few redds observed in the Lower Healdsburg reach were found near the upstream end of the reach near the confluence with Dry Creek. Redds in the Upper Healdsburg reach were clustered in the center and upstream end of the reach. In the Alexander Valley, redds were clustered in the center of the reach. Redds were distributed throughout both the Canyon and Ukiah reaches. In Dry Creek, redds were distributed throughout the reach, except the lower area. Although we did not quantify habitats in the study area, nearly all of the sites that appeared suitable for Chinook salmon spawning were utilized. Redds throughout the study area were found almost exclusively in riffle habitats with course gravel to small cobble sized substrate and water depths greater than 20 cm.

Chinook salmon redd in small cobble substrate

The frequency of Chinook salmon redds was highest in the Dry Creek and Ukiah reaches, which are impounded at the upstream end by dams. Dry Creek is accessible to Chinook salmon from the Russian River confluence for approximately 22 km before ending at the Warm Springs Dam, Lake Sonoma, and the Don Clausen Fish Hatchery (Figure 8). During 2003, the Dry Creek reach contributed 22% of the observed redd production for the entire year, totaling 256 redds in Dry Creek. Relatively few Chinook salmon redds (16.8%) occurred in the lower half of Dry Creek, below Lambert Road bridge, and no redds were observed within 4 km of the confluence with the Russian River (Figure 9). The upper segment of the Dry Creek reach contained 83.2% of the redds. In general, the abundance of redds increased with proximity to Warm Springs Dam. The highest number of redds occurred within 2 km of the dam and contained 76 redds. Similarly, the largest frequency of redds in the Ukiah reach was at the upstream end at the confluence of the East and West Forks of the Russian River (Figure 10). The East Fork of the Russian River extends 0.6 km upstream from the Forks before ending at Coyote Dam, Lake Mendocino. One hundred and twenty-five redds were observed 2 km below the Forks confluence at a frequency of 62.5 redds/km.



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Location Map

Chinook Salmon Spawning Study, Russian River Fall 2002 and Fall 2003

Figure 3

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UKIAH REACH (Northern)

0 0.25 0.5 0.75 1
Miles
0 0.25 0.5 1 1.5 2
Kilometers
N
W E
S

Legend

- Redd Numbers, Fall 2002
- Redd Numbers, Fall 2003

UKIAH

FEBRUARY 24, 2004

\SPECIAL PROJECTS\FISHERIES\ESTUARY_FISH_STUDY\REDD-UKIAH-NORTH.mxd

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Chinook Salmon Redd Sites, Ukiah Reach (Northern)

Chinook Salmon Spawning Study, Russian River Fall 2002 and Fall 2003

Figure 4A

UKIAH REACH (Southern)

Miles: 0 0.25 0.5 1

Kilometers: 0 0.25 0.5 1 1.5 2

N E S W

Legend

- Redd Numbers, Fall 2002
- Redd Numbers, Fall 2003

Russian River

HOPLAND

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Chinook Salmon Redd Sites, Ukiah Reach (Southern)

Chinook Salmon Spawning Study, Russian River Fall 2002 and Fall 2003

Figure 4B

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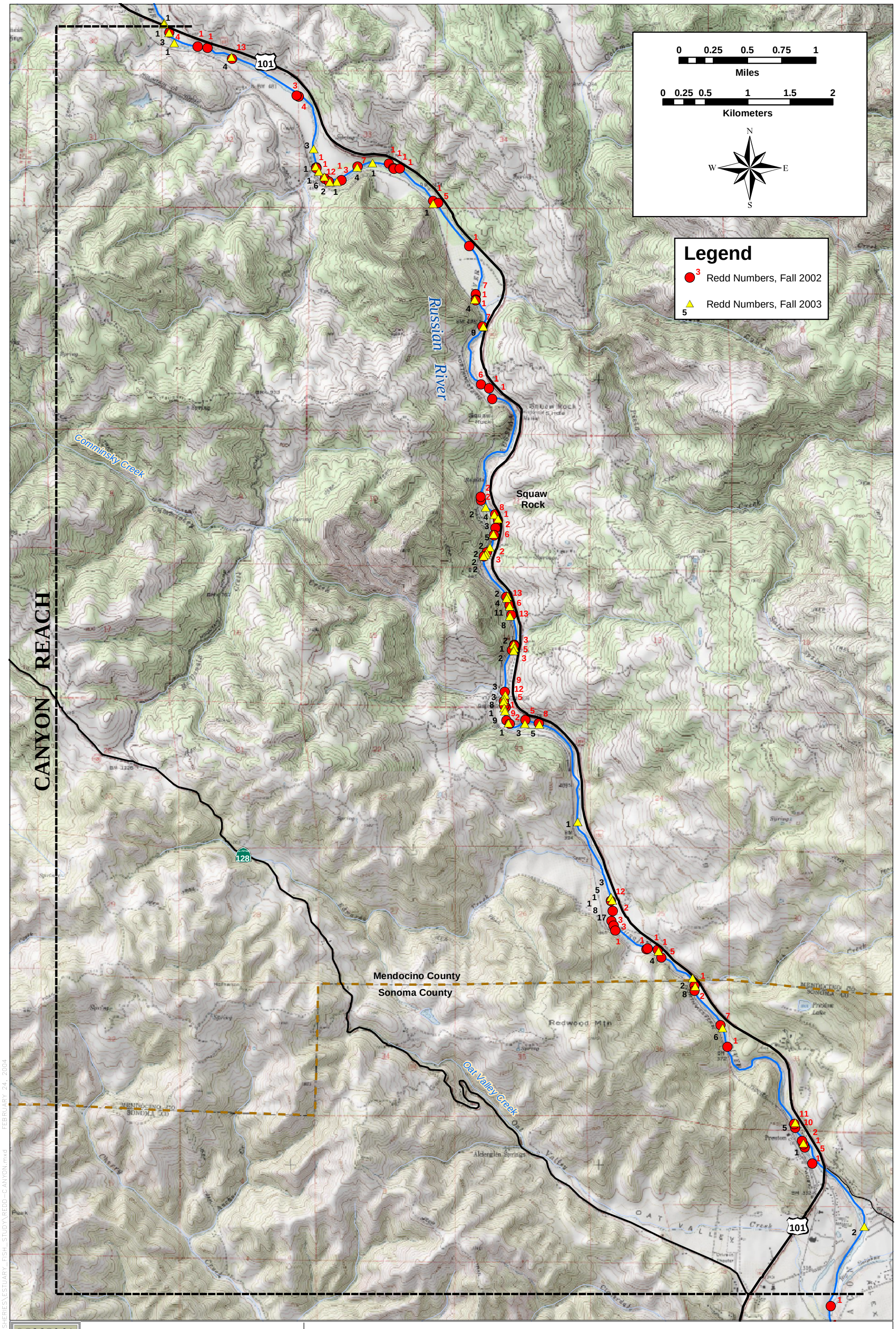

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Chinook Salmon Redd Sites, Canyon Reach

Chinook Salmon Spawning Study, Russian River Fall 2002 and Fall 2003

Figure 5

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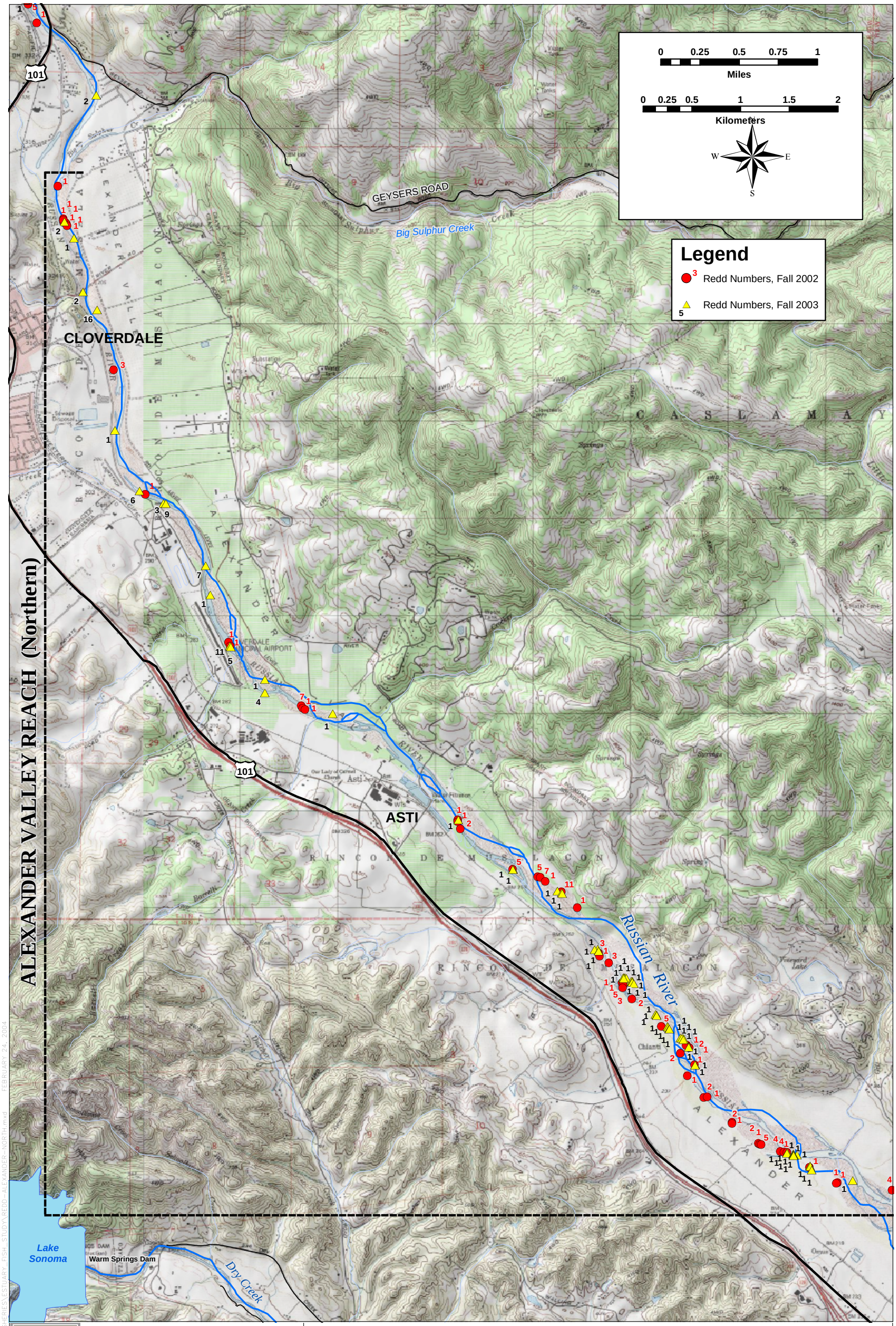

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Chinook Salmon Redd Sites, Alexander Valley Reach (Northern)

Chinook Salmon Spawning Study, Russian River Fall 2002 and Fall 2003

Figure 6A

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ALEXANDER VALLEY REACH (Southern)

0 0.25 0.5 0.75 1
Miles
0 0.25 0.5 1 1.5 2
Kilometers
N W E S

Legend

- Redd Numbers, Fall 2002
- Redd Numbers, Fall 2003

Miller Creek
Russian River
GEYSERVILLE
GEYSERS ROAD
Lytton
HEALDSBURG
Dry Creek
ALEXANDER VALLEY
SOTOYOME

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Chinook Salmon Redd Sites, Alexander Valley Reach (Southern)

Chinook Salmon Spawning Study, Russian River Fall 2002 and Fall 2003

Figure 6B

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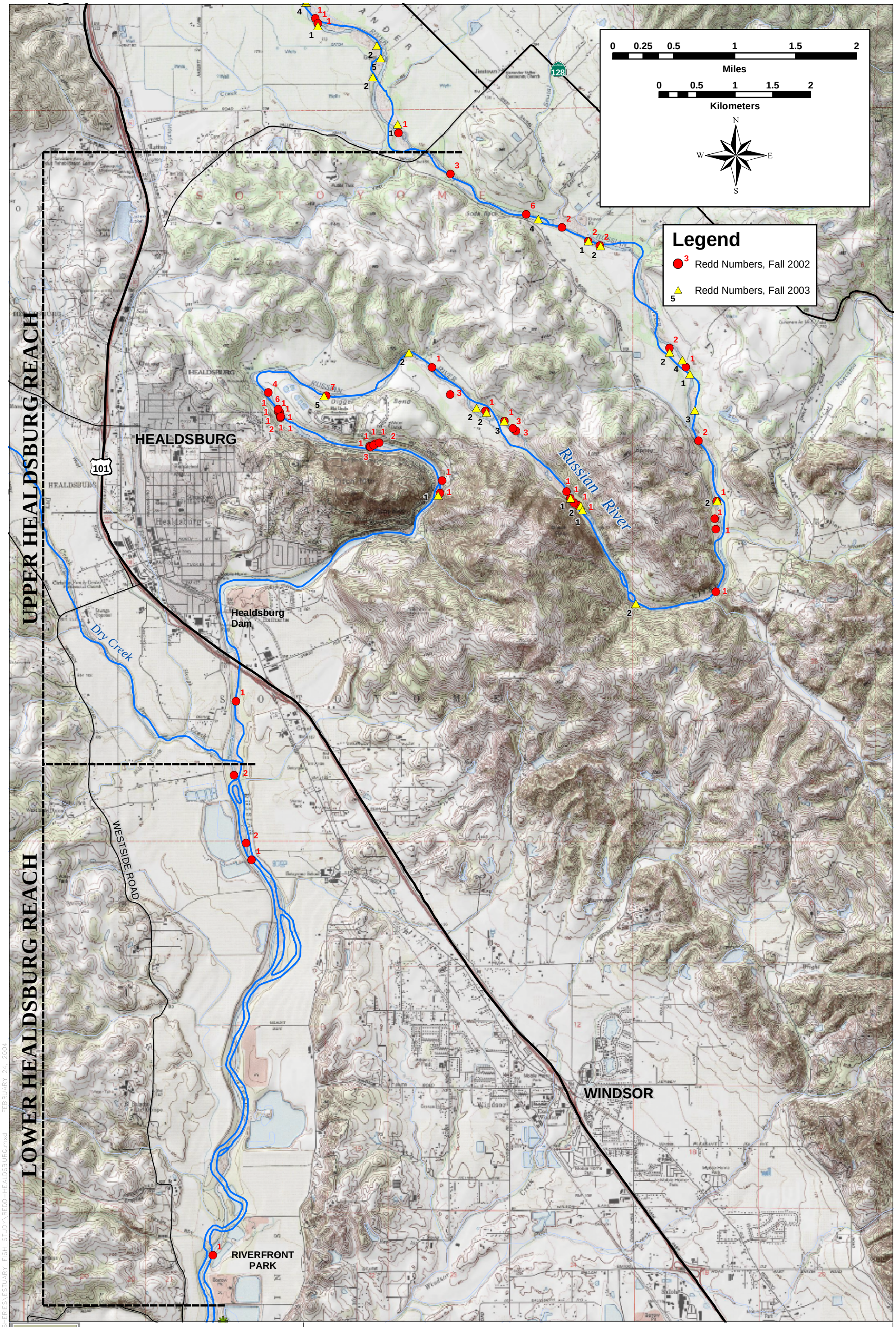

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Chinook Salmon Redd Sites, Upper & Lower Healdsburg Reach

Chinook Salmon Spawning Study, Russian River Fall 2002 and Fall 2003

Figure 7

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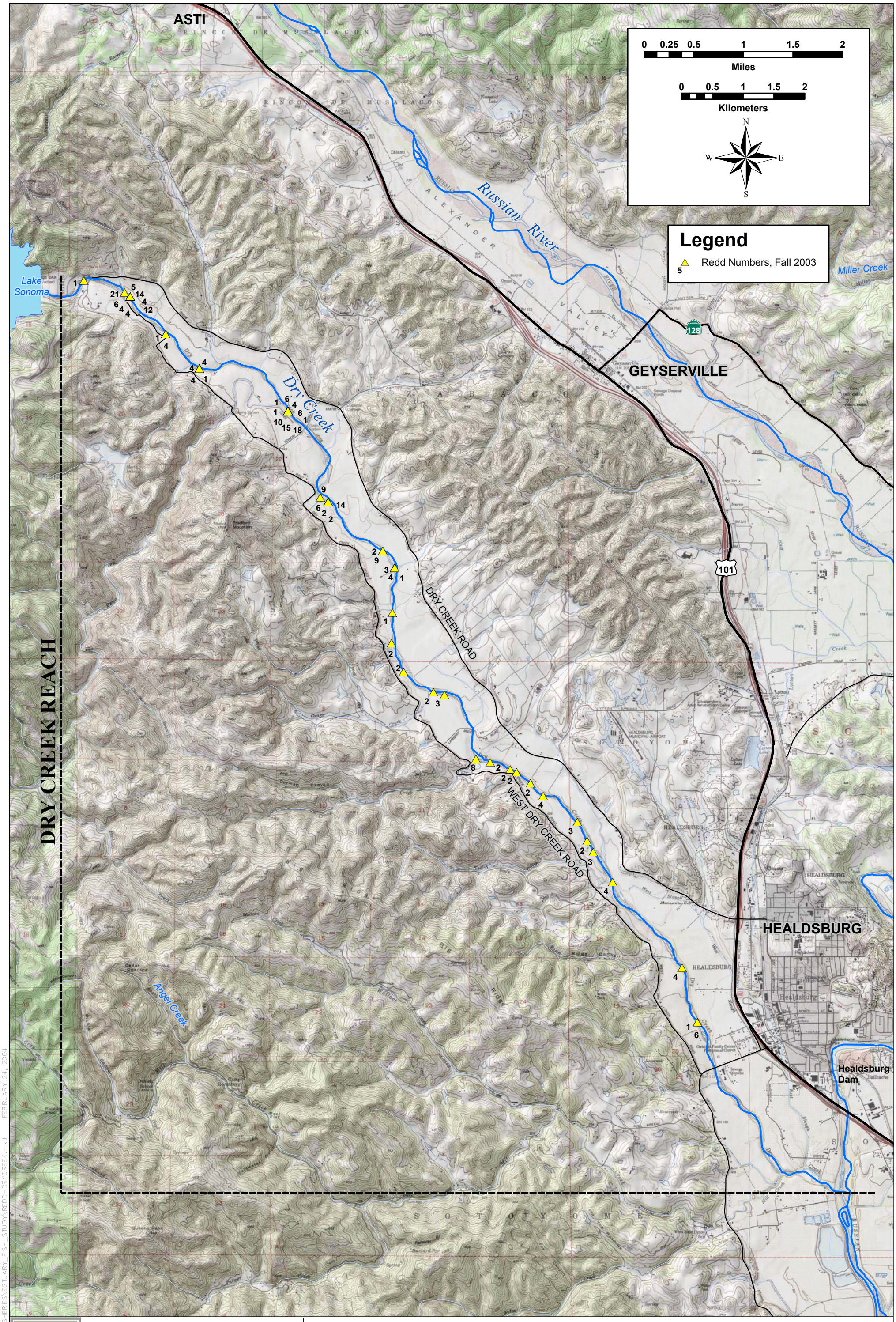

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Chinook Salmon Redd Sites, Dry Creek Reach (Fall 2003 Only)

Chinook Salmon Spawning Study, Russian River Fall 2002 and Fall 2003

Figure 8

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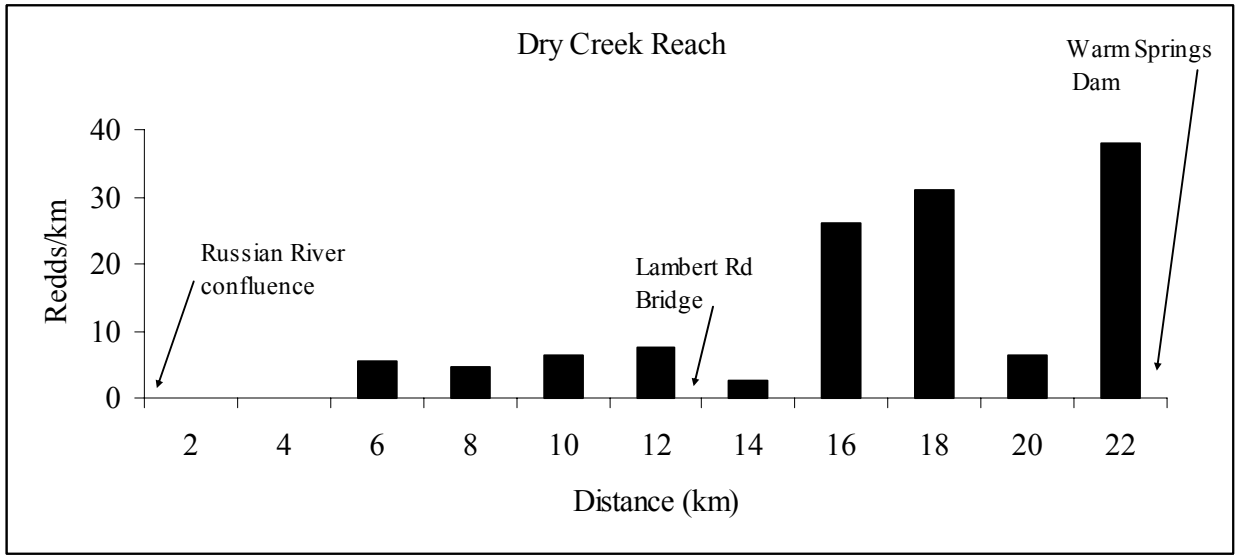

Figure 9: Distribution of Chinook salmon redds in the Dry Creek reach.

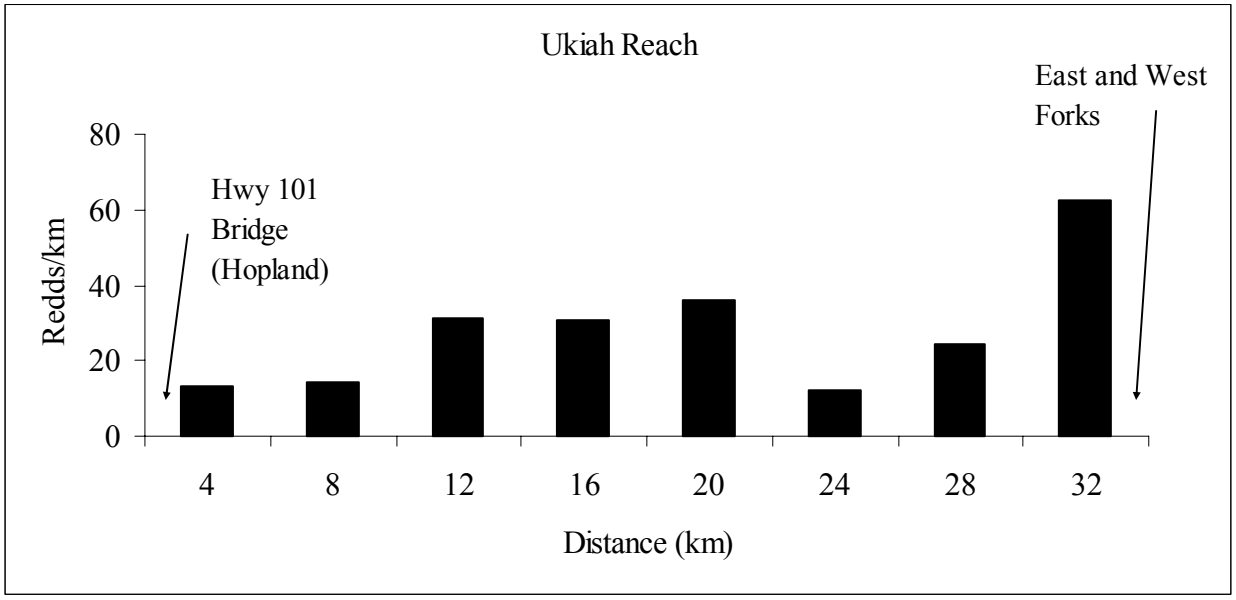

Figure 10: Distribution of Chinook salmon redds in the Ukiah reach.

CONCLUSIONS

The disproportionately high counts of adult Chinook salmon observed during video monitoring compared to redd counts suggests that many more redds were deposited than were observed. There was approximately 5 times the number of migrating adults observed than redds. Based on an assumed 1-to-1 sex ratio, there could have been 2 to 3 times as many redds deposited as observed in our 2-year study. This discrepancy is probably due to the superimposition (overlapping) of deposited redds, spawning after surveys were completed, and spawning in tributaries that were outside of the study area.

An unprecedented number of Chinook salmon were documented spawning in the upper Russian River during fall 2002 and 2003. Anecdotal accounts during the past century suggest that Chinook salmon in the Russian River were nearly extinct or at very low levels historically. This two-year study documented over 1,000 redds during each study year in the upper Russian River basin. Most of the redds were distributed in the Ukiah, Canyon, Alexander Valley, and Dry Creek reaches. The highest densities were in the Ukiah and Dry Creek reaches. The frequencies in the Upper Healdsburg and Lower Healdsburg reaches were very low or 0. This is consistent with our observation of riffle habitat with substrate suitable for Chinook salmon spawning occurring primarily above Upper Healdsburg reach and in Dry Creek reach.

Redds were concentrated in the Ukiah and Dry Creek reaches near the terminus with a dam. Releases of relatively cool, high flows of water from these dams are strong attractants for migrating Chinook salmon. Relatively cool flows from Lake Sonoma (D. Cook pers. obs.) contributed over one-third of the flows in the Russian River below their confluence, which is probably the primary factor that attracted large numbers of Chinook salmon to Dry Creek to spawn.

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